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ENGINE OIL SYSTEM WITH OIL PRESSURE REGULATOR TO INCREASE CAM PHASER OIL PRESSURE

TECHNICAL FIELD

[0001] This invention relates to engine oil systems and, more particularly, to a system including a pressure regulator to optimize oil flow and pressure for various lubrication and actuation functions.

BACKGROUND OF THE INVENTION

[0002] Internal combustion engines may use lubricating oil for many purposes including, for example, lubricating moving parts, actuating cam phasers, and controlling valve lifters for cylinder deactivation. Cam phasers and cylinder deactivation devices generally require a higher oil pressure for actuation during engine operation than the moving parts of the engine require for proper lubrication.

[0003] One approach to maximize engine efficiency is to use a smaller oil pump to provide only the minimum amount of oil pressure needed to prevent engine wear. However, smaller oil pumps do not provide enough oil pressure to actuate a cam phaser at low and idle engine speeds. Thus the cam phaser can be operated only at higher engine speeds.

[0004] Another approach is to use a larger oil pump to provide enough oil pressure to operate the cam phaser at low engine speeds. This approach allows phasing at lower engine speeds to alter the valve timing and increase engine efficiency. However, the efficiency gains are not without cost. A higher pressure produced by larger oil pump supplies excess flow that over lubricates the moving parts of the engine and requires additional energy to drive the pump, creating parasitic losses that reduce engine efficiency.

[0005] A method is desired of selectively regulating oil pressure throughout an engine to increase engine efficiency while allowing the engine

to operate a cam phaser or cylinder deactivation devices at low engine speeds without having to greatly increase oil pump output.

SUMMARY OF THE INVENTION

[0006] Co-pending applications pertaining to related subject matter were filed concurrently with this application on ______________, 2003 as U.S. Application No. _____________ (GP-303043), U.S. Application No. ________________(GP-303044), and U.S. Application No. ______________ (GP-303046).

[0007] The present invention provides an oil system for an internal combustion engine having a pressure regulator to optimize oil pressures in the engine while increasing engine efficiency by minimizing parasitic losses created from over lubrication.

[0008] In an exemplary embodiment, the oil system includes an oil pump having an inlet and an outlet. An oil pickup connected with the inlet extends into an engine oil sump to draw oil into the oil system. The outlet of the oil pump connects to a main oil feed which supplies oil to a main bearing gallery and a hydraulically actuated device such as a cam phaser or switching lifters. Oil sent to the cam phaser is used to actuate the cam phaser, while oil directed to the main bearing gallery is used primarily for lubrication purposes. When switching lifters are present, some of the oil directed to the cam phaser is diverted to a control, which supplies oil pressure to the switching lifters to allow valve stepping and cylinder deactivation. In addition, some of the oil pumped into the main bearing gallery is sent through a cam gallery feed to a cam gallery in an upper part of the engine for lubrication of a valve train.

[0009] A pressure regulator connected between the main oil feed and the main bearing gallery selectively limits oil flow to the main bearing and cam galleries. The regulator includes an orifice to limit oil flow into the galleries

under low oil pressure conditions, and a bypass valve opening to increase oil flow into the galleries under higher oil pressure conditions.

[0010] The restriction of oil flow to the main gallery created by the regulator forms back pressure which increases oil pressure in the main feed. The increased oil pressure within the main feed is then directed to the hydraulically actuated device. As a result, the amount of oil pressure to the hydraulically actuated device is increased while the rest of the oil system operates at a lower oil pressure. This allows cam phasing or cylinder deactivation at engine idle or other conditions when oil pump pressure is normally too low to actuate the cam phaser or the switching lifters. The additional oil pressure supplied to the hydraulically actuated device allows the phaser to vary valve timing at all engine speeds without a large increase in the size of the oil pump. The use of a smaller oil pump reduces parasitic losses for increased engine efficiency.

[0011] These and other features and advantages of the invention will be more fully understood from the following description of certain specific embodiments of the invention taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a pictorial view of an internal combustion engine including an oil system with a cam phaser according to the invention;

[0013] FIG. 2 is a pictorial view of a portion of a direct acting valve train with switching lifters having parts broken away to show interior features of the components;

[0014] FIG. 3 is a pictorial view of an exemplary oil system for the engine of FIG. 1; and

[0015] FIG. 4 is a pictorial view of a pressure regulator for the oil system.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] Referring now to FIG. 1 of the drawings in detail, numeral 10 generally indicates an internal combustion engine. The engine includes a cylinder block 12 having a bank of cylinders 14 containing pistons 16 connected with a crankshaft 18. A cylinder head 20 carries intake and exhaust valves 21, 22 actuated by camshafts 24, 26. A cam phaser 28 is mounted on the exhaust camshaft 26 to vary the exhaust valve timing. An oil pan 30 below the block forms an oil sump for the engine.

[0017] FIG. 2 illustrates an exhaust portion of an engine valve train 32 for use in an overhead cam piston type engine. The valve train 32 includes exhaust camshaft 26 which is driven through a drive sprocket 34 connected by a chain 36 with the engine crankshaft 18. Cam phaser 28 is connected between the sprocket 34 and the camshaft 26 in order to vary the timing of the camshaft relative to the piston motion and other operating functions of the engine and relative to other camshafts of the engine.

[0018] The exhaust valves 22 are actuated through switching valve lifters 38 which are engaged by cams 40 of the camshaft 26. The switching valve lifters 38 react to oil pressure to deactivate or selectively change the amount of valve lift provided for the associated exhaust valves 22. A controller 42 receives oil pressure and distributes or cuts off the control pressure to the switching lifters 38 to actuate the valve train 32. The controller 42 may supply oil pressure to the switching lifters 38 to reduce valve lift or disable valve lift for cylinder deactivation.

[0019] FIG. 3 illustrates an oil system 43 within the engine 10. The oil system includes an engine driven oil pump 44 having an inlet 46 and an outlet 48. An oil pickup 50 connected with the pump 44 extends into the sump of the oil pan 30. The pump 44 connects through an oil filter 52 with a main oil feed 54. The main oil feed 54 distributes oil to a cam phaser feed 56 and a main bearing gallery 58. The main bearing gallery 58 supplies oil

to crankshaft main and connecting rod bearings, not shown. The main bearing gallery 58 connects to a cam gallery feed 60 which carries oil to a cam gallery 62 for lubricating camshaft bearings and valve gear 64 within the cylinder head 20 of the engine 10.

[0020] In accordance with the invention, a pressure regulator 66, as shown in FIG. 4, is connected between the main oil feed 54 and the main bearing gallery 58. The pressure regulator 66 has a tubular housing 68 surrounding a slidable flow control piston 70. The piston 70 internally defines an orifice 72. A biasing spring 74 between the piston and an outlet end 76 of the housing 68 urges the piston 70 toward an inlet end 78 of the housing, to close a large inlet opening 80 in the housing 68. A plurality of bypass openings 82 extend through a tubular wall of the housing 68 adjacent the inlet end 78.

[0021] During engine operation, the oil pump 34 draws oil from the oil pan 30 through the oil pickup 50. The oil is then pumped through the pump outlet 48 and oil filter 52 to the main oil feed 54.

[0022] Under low oil pressure conditions, the biasing spring 74 holds the flow control piston 70 against the inlet end 78 of the housing 68, closing the inlet opening 80 and the bypass openings 82. Thus, oil flow to the main bearing gallery 58 and the cam gallery 62 passes only through the piston orifice 72.

[0023] As oil pressure increases at the inlet end 78 of the housing 68, the piston 70 begins to slide toward the outlet end 76 and compress the biasing spring 74. As the piston 70 moves toward the outlet end 76, the bypass openings 82 begin to open, allowing oil to flow from the large inlet opening 80 of the housing 68 though the bypass openings 82. This oil bypasses the piston orifice 72 and increases oil flow through the pressure regulator 66. As oil pressure on the inlet end 78 of the housing 68 is reduced, the biasing spring 74 urges the piston 70 back toward the inlet end 78, closing the bypass openings 82 and reducing oil flow through the pressure regulator 66.

[0024] At lower engine speeds while oil pump output is minimal, flow to the main bearing gallery passes through the orifice 72 of the pressure regulator 66. The orifice acts as a restriction that increases oil pressure at the pump outlet 48 and to the cam phaser 28. This allows the cam phaser 28 to be actuated during idle and low rpm conditions. In addition, the control 42 may supply oil pressure to the switching lifters 38 to allow the valve train to reduce valve lift or deactivate cylinders.

[0025] As engine speed increases, the output from the oil pump 34 increases, causing the overall oil pressure in the system 43 to increase. As oil pressure increases at the inlet end 78, the piston 70 slides toward the outlet end 76 against the biasing spring 74. The movement of the piston 70 opens the bypass openings 82. This reduces the restriction to flow through the pressure regulator 66 and thereby limits the pressure increase at the pump outlet and to the cam phaser 28 to a pressure suitable for phaser operation at all engine speeds.

[0026] While the invention has been described by reference to certain preferred embodiments, it should be understood that numerous changes could be made within the spirit and scope of the inventive concepts described. Accordingly, it is intended that the invention not be limited to the disclosed embodiments, but that it have the full scope permitted by the language of the following claims.